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**Nutrient intake and factors influencing eating behaviors in older migrant women
living in the UK**

Original Article

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Nutrient intake and factors influencing eating behaviors in older migrant women living in the UK

This study examines nutrient intake and factors influencing eating behaviors in a sample of 76 migrant older women (≥ 60 years) living in the UK. Nutrient intake was assessed using a single 24-hr recall enhanced by an in-depth probing dietary interview. Median energy intake was significantly lower than the UK Reference Nutrient Intakes (5125.4 v. 7301.1 kJ/d, $p < 0.001$). Main nutrients of concern were retinol, vitamin D, magnesium, potassium, copper, selenium, and monounsaturated fatty acids. Additionally, semi-structured interviews were conducted with a sub-sample ($n=46$) and analyzed using an inductive thematic approach. Findings revealed that although women were knowledgeable about what constitutes a healthy diet, factors such as the presence and awareness of obesity and non-communicable diseases, changes to home environments and household roles, and dietary restrictions related to religious beliefs were identified as key influences on participants' dietary intake. Future interventions for migrant older women from ethnically diverse background should consider the social component of cooking and eating, as well as food beliefs and traditions. In addition, strategies targeting this population with high rates of nutrition-related non-communicable diseases need to promote not only a healthy energy balance, but also dietary adequacy to optimize nutrient intake.

Keywords: dietary intake, eating behaviors, older women, ethnicity, immigrant

Nutrient intake and factors influencing eating behaviors in older migrant women living in the UK

Nutrient intake and key factors influencing eating behaviors in migrant older adults living in the UK remains understudied. Previous studies assessing dietary intake of migrant populations or ethnic minorities in the UK are based on cohorts of children or young to middle-aged adults (Lawrence et al. 2007; Donin et al. 2010) and seldom include individuals aged 60 years and older. Available data on health outcomes and dietary intake have focused mainly on South Asian and African-Caribbean ethnic groups (Sharma et al. 1999; Garduño-Díaz and Khokhar 2014). However, the UK population is becoming increasingly diverse, especially among the cohort of older adults. Population estimates predict that by 2051, there will be 6.6 million minority ethnic people aged 65 years and older in England and Wales (Lievesley 2010). Notably, women will compose a large proportion of this population and are likely to be disproportionately affected by poor health and long-term conditions, increasing their risk for physical decline and reducing quality of life in comparison to their white British counterparts (Evandrou 2000). Given the recognized health disparities between migrants –mainly of non-Western origin– and the general population, researchers have focused on exploring dietary behaviors that help explain higher rates of obesity and related non-communicable diseases (Garduño-Díaz et al. 2013). Nonetheless, the evidence available on older migrants to Western countries has suggested that these individuals, especially those migrating later in life, are vulnerable to poor nutrition due to diverse factors such as language barriers, dietary traditions, special needs, and acquisition of unhealthy lifestyle behaviors (Johnson and Garcia 2003). Poor nutrition among older adults contributes to the progression of existing non-communicable diseases as well as increasing the risk for functional decline, impaired quality of life, and premature mortality (Payette and Shatenstein 2005). It is well known that community-dwelling older adults often fail to meet current nutritional guidance (Montgomery et al. 2014), but contemporary evidence characterizing the nutrient intake of first generation migrant older women from ethnically diverse backgrounds living in the UK is lacking.

1 Furthermore, eating behaviors are complex and involve a myriad of psychological, biological, personal, social and environmental factors
2 (Johnson-Askew, Fisher, and Yaroch 2009). In addition to exploring what individuals eat, there is a need to understand the drivers of eating
3 behaviors to allow for the development of appropriate dietary advice and behavior change interventions. In Europe, eating behaviors and
4 particularly, dietary acculturation –the process by which migrants adopt new dietary practices– has been explored mainly in younger migrant
5 women (Garnweidner et al. 2012; Terragni et al. 2014). Yet, data from older women (≥ 60 years) is needed in order to understand if, and how,
6 the factors that influence eating behaviors in young women differ from those of older women. This knowledge will allow for appropriate
7 tailoring of nutrition-related advice to this growing segment of the UK population.

8 To address these gaps in the literature, the aims of this study were to: (1) examine energy and nutrient intakes in a sample of
9 migrant older women from ethnically diverse backgrounds in comparison to the UK Reference Nutrient Intake Values (RNI), and (2)
10 obtain a greater understanding of key factors influencing participants' eating behaviors.

11 **Methods**

12 *Study design*

13 This study employed a sequential mixed-methods approach (Creswell and Plano Clark 2011). The first phase of the study involved assessing
14 dietary intake using a 24-hr dietary interview recall. The second phase employed a semi-structured interview to further explore participants'
15 dietary intake and key factors influencing eating behaviors. Approval was granted by the ethical review committee of the University of "X".
16 Written informed consent was obtained from all participants. Data were collected between January 2013 and June 2015.

1 *Study population*

2 A convenience sample of 76 older women was recruited to participate in the study using maximum variation sampling to achieve our goal of
3 recruiting a sample across the range of age, migration backgrounds, level of deprivation, and predominant ethnic groups living in the geographic
4 region. This purposive sampling technique was employed to provide a greater depth of information from a smaller number of carefully selected
5 participants rather than providing a greater breadth of information from a larger number of participants selected to be representative of the
6 population (Teddlie and Yu 2007), which is commonly employed in mixed-methods studies. Access to various ethnic groups was obtained by
7 contacting local community leaders and individuals at community centers and places of worship. Inclusion criteria included being aged 60 years
8 and older, born outside the UK, and no previous history of a medical condition affecting memory (e.g., dementia). Interpreters were available
9 during all phases of recruitment and data collection for non-English speakers.

10 *Data Collection*

11 *Dietary assessment*

12 A single 24-hr dietary recall was conducted following a face-to-face multi-pass method (Garduño-Díaz and Khokhar 2014), to obtain detailed
13 information on all food and beverages consumed. The 24-hr dietary recall was enhanced by an in-depth probing dietary interview to gather
14 further details that quantitative methods may fail to capture (such as added fats, sugar, sauces and salt) as well as important cultural food
15 practices and traditions (Kruger et al 2012). A set of tailored, probing questions, rather than a structured interview schedule, was employed to
16 prompt for specific details related to the food practices of each ethnic group (such as the use of ghee for South Asians). Examples of probing
17 questions include: Do you commonly eat breakfast, and if so, what would you commonly eat for breakfast? What type of milk do you use to
18 prepare your tea? What type of spread do you use for your toast? Do you normally add any extra salt or sauces (e.g. tomato sauce) during

1 cooking or to your meal once prepared (ie, at the table)? Portion sizes were estimated using a photographic food atlas that includes a wide range
2 of ethnic dishes, as well as a wide selection of household measurements relevant to the UK (Nelson, Atkinson, and Meyer 1997). A second 24-hr
3 dietary recall was conducted when there were inconsistencies between the dietary interview and the initial 24-hr dietary recall, or when an
4 implausible energy intake was reported (<1673.6 kJ/d) ($n=5$). The first author (XXX), a dietitian trained in dietary assessment, conducted all 24-
5 hr recalls. Data coding and processing was conducted by XXX, with oversight from XXX. These procedures enabled a standardized data entry
6 and analysis process. Nutrient analysis was conducted using DietPlan6 software (Forestfield software Ltd 2006, Horsham, UK) that included a
7 supplement database containing commonly consumed ethnic foods in the UK. In addition, recipe information (including cooking method, fat
8 used, salt, and spices) and multi-vitamin/mineral supplements consumed were entered into the database. Information about supplement use was
9 obtained at the time of the in-depth probing dietary interview, including brand and quantity of the supplement taken, and also frequency of
10 taking the supplement. When the participants were unable to report brand names, the micronutrient content of the most commonly consumed
11 single nutrient and multi-vitamin/mineral supplements were used as the default. Participants' nutrient intake data were compared to the UK RNIs
12 for older women (>50 y) (DoH 1991; SCNA 2012).

13 *Anthropometry and Physical Activity*

14 Height was measured to the nearest 0.1 cm (SECA 213 portable stadiometer) and weight to the nearest 0.1 kg (SECA 899 digital scale) in
15 duplicate, and then averaged. All anthropometric measurements were taken with the participant wearing light clothing and no shoes. BMI was
16 calculated as weight divided by height squared (kg/m^2). The BMI cut-points for the Arab, Indian, Pakistani and Bangladeshi participants were
17 those recommended by the WHO for Asian population (BMI of <18.5 ; $18.5\text{--}23$; >23 , and >27.5 kg/m^2 for underweight, normal weight,
18 overweight and obese categories, respectively) (Barba et al. 2004). Self-reported physical activity was measured using the International Physical
19 Activity Questionnaire short-form modified for the elderly (www.ipaq.ki.se).

1 *Socio-demographic variables*

2 Demographic information was collected via a researcher-administered questionnaire. The English Index of Multiple Deprivation (IMD) was
3 used as a socioeconomic indicator and was determined based on residential postcodes (DCLG 2015).

4 *Semi-structured interviews*

5 A purposive sub-sample of participants ($n=46$) across the range of ethnic groups, deprivation, and age took part in a semi-structured interview
6 exploring both dietary and PA behaviors within the context of migrating and ageing in a multi-cultural community. All interviews were
7 conducted by the first author at the participants' location of choice, and ranged between 40-78 minutes. Where interviews were conducted with
8 the aid of an interpreter in a language other than English, translations were done during the interview ($n=16$). For the purposes of this study, we
9 report the qualitative data examining factors that influenced participants' eating behaviors and dietary intake.

10 *Data analysis*

11 *Quantitative data*

12 Descriptive data (mean and standard deviation or frequency and percentage) were generated for the sample. Energy and nutrient intakes were
13 reported as median and interquartile range (the difference between the 25th and 75th percentiles) due to the skewed nature of the data. Median
14 nutrient intakes for the full sample were compared to the UK RNIs using the one-sample Wilcoxon signed rank test. The 95% confidence
15 intervals of the difference between the median intakes of participants and the RNI were calculated following the method by Campbell & Gardner
16 (2001). All statistical analyses were conducted using SPSS 21 (IBM Corp, Armonk, NY). Significance was set at $p<0.05$.

1 *Qualitative data*

2 All interviews were audiotaped and transcribed verbatim. Given the exploratory
3 nature of the study, inductive thematic analysis (Braun and Clarke 2006) was used to
4 identify themes strongly linked to the data rather than fitting themes to a pre-existing
5 framework. Initially, the first author and two independent researchers coded a set of
6 transcripts. An initial coding frame was developed in which codes were organized
7 into higher and lower level themes. All of the transcripts were subsequently coded by
8 the first author. Finally, the coding was reviewed and refined in several discussions
9 with all authors until consensual validation was reached. NVivo10 qualitative analysis
10 software (QSR International Pty Ltd, Melbourne, Australia) was used to organize the
11 data.

12 **Results**

13 *Quantitative Findings*

14 Table 1 presents the general characteristics of the sample. On average, participants were 70.5 ± 7.6 years, reported having 2.3 ± 1.5 diseases
15 previously diagnosed by a GP (General Practitioner); with hypertension (55.3%) and type 2 diabetes (38.2%) the most common. Almost 88% of
16 the sample was classified as overweight or obese; none of the participants were classified as underweight. Over 27% of participants were born in
17 Jamaica, Montserrat, or St Kitts and Nevis; 13.2% in Eritrea, Somalia or Sierra Leone; 10.5% in Yemen; 6.6% in Ireland, and 35.5% of Indian
18 and Pakistani women were born in the Indian subcontinent or East Africa. Participants came from all socio-economic levels; 79% were

categorized as being in the 2 most socio-economically deprived quintiles, based on the English indices of deprivation. Almost 40% of the sample ($n=30$) reported taking a supplement on a regular basis. Seventy percent of participants ($n=53$) self-reported low levels of PA (≤ 600 MET min/wk).

[Insert Table 1]

Energy and Nutrient Intake

As shown in Table 2, median energy intake was significantly lower (5125.4 v. 7301.1 kJ/d, $p<0.001$) than the estimated average requirement for older adults (>65 y), based on the needs of a general population with a low PA level. We used low PA level as a reference based on the self-reported measured PA level of the study sample, who reported being highly sedentary. Although several of the UK RNI values were met, median intakes of retinol ($p<0.001$), vitamin D ($p=0.02$), magnesium ($p<0.01$), potassium ($p<0.001$), copper ($p<0.01$), selenium ($p<0.001$), and monounsaturated fatty acids ($p<0.001$) were significantly lower than the recommendations. In contrast, median sodium intake ($p<0.001$) and the contributions of total fat ($p=0.02$), and trans-unsaturated fatty acids ($p<0.001$) to total energy intake were significantly lower than the RNI values and thus, met current recommendations.

[Insert Table 2]

1 *Qualitative Findings*

2 The analysis of interview transcripts revealed two major themes influencing current dietary intake: (1) personal, and (2) socio-cultural factors.
 3 Table 3 includes a summary of the major themes and sub-themes. Specific excerpts are reported for each theme to support the findings. Excerpts
 4 that appear in the third person are those from an interview conducted with the aid of an interpreter.

5
 6 **[Insert Table 3]**

7 *Personal factors*

8 The sub-themes related to personal factors affecting current dietary intake included knowledge and perceptions of their diet, increased awareness
 9 of obesity and non-communicable diseases, digestion problems, changes in PA, and health care provider advice.

10

11 *Knowledge and perceptions of their diets*

12 Overall, there was a good knowledge about what constitutes a healthy diet and current nutritional guidance. Some participants were aware of the
 13 nutrients contributing to their perceptions of their diet being more or less healthy:

14 “Making sure that you’ve got iron in there, you’ve got your vitamins, your proteins in there” (Indian, 74y).

15 “Checking out [control the amount of] your fats and carbohydrates” (Irish, 72y).

16

17 Similarly, participants gave examples of what they commonly considered as “healthy eating” including brown bread, fruits and vegetables, fish
 18 and low-fat products. In general, most participants described their diet and nutrient intake as being healthy:

1 “I am eating healthy, I don't eat that much chips [French fries]... I don't eat chocolates... I eat lots of vegetables and I know I like
2 chapattis, but I even eat boiled food as well” (Pakistani, 61y).

3
4 *Increased awareness of obesity and non-communicable diseases*

5 The therapeutic restrictions on their diets as a consequence of a medical condition was particularly salient for participants who had a higher
6 presence of chronic diseases and who tended to self-report poorer health, as one participant with multiple medical conditions reported:

7 “So many things I’m not having due to diabetes and so many things I’m not having for blood pressure, so many things I’m not having for
8 cholesterol, the food that we are eating has changed, before we were eating fried food and now we stopped completely” (Pakistani, 62y).

9
10 Many participants reported feeling that at an old age it is imperative to make dietary changes and trying to lose weight. This awareness was
11 based on previous experiences as a carer for a family member with diabetes, as well as a high prevalence of diabetes among acquaintances and in
12 some cases being personally at risk (i.e., glucose intolerant):

13 “At a young age, they weren’t in my mind these things, we didn't know about it, blood pressure, we didn't know at all about diabetes, no!
14 But now we are hearing these things [people being diagnosed with a disease] and then, I worry about it” (Pakistani, 64y).

15
16 Reducing their energy intake overall, or reducing intake of certain food items (i.e., sugar, fat, salt, and red meat) were reported as common
17 strategies to prevent nutrition-related non-communicable diseases:

18 “I am cutting the things [oily foods and sweets] and I am trying to lose weight...you have to, when you see some people are like this you
19 know, suffering, you have to do that, you never know if you can catch [develop] it or not at this age” (Pakistani, 62y).

1 *Digestion problems*

2 Digestion problems appeared to be a key factor affecting not only the amount of food consumed, but also the cooking methods and the type of
 3 foods they were consuming. Not being able to digest “big amounts of food” as they used to, was reported as a normal process of age. While
 4 following the same dietary habits (e.g., eating spicy and oily food) was perceived as a food habit that could aggravate their digestion problems.
 5 Spices, oily foods and staple foods (e.g., chapattis) were common food items being cut down or removed from their diets to avoid gastritis,
 6 reflux or indigestion:

7 “She has gastritis and because of that she tells me to put less oil in the food... if she eats too much, she is worried she will get more
 8 illnesses” (Bangladeshi, 65y).

9

10 *Changes in their PA*

11 Participants also identified a loss of appetite, emphasizing that they eat because they “have to” and not because they are hungry. This appetite
 12 loss was commonly related to changes in their daily activity level compared to when they were younger and more physically active. The sharp
 13 decrease in PA due to age was common among study participants but appeared to be more marked in women who migrated to the UK more
 14 recently. For instance, Somali participants associated their appetite loss with the sedentary lifestyle they had in the UK in comparison to their
 15 home countries, where a lack of access to public or motorized transport and physically demanding housework kept them more active:

16 “She is eating because she has to, she decreased the amount of food she’s taking and also she’s thinking about her weight [...] In this
 17 country you sit all the time but in Somalia you eat a lot, but you walk all the time...there is no public transport” (Somali, 74y).

18

19 *Health care provider advice*

1 Participants commonly reported receiving dietary advice to encourage the maintenance of normal blood glucose levels and a healthy body
 2 weight. However, few reported receiving any specific advice about nutrient adequacy unless this was part of their medical treatment (e.g.,
 3 anemia, heart disease). Awareness of nutrient deficiencies was not commonly highlighted, although 40% ($n=30$) of the study sample reported
 4 taking a nutrient supplement on a regular basis. Some participants reported taking multivitamins following encouragement from family
 5 members. Notably, taking multivitamin/mineral supplements did not necessarily result in women meeting the RNIs. In some cases ($n=8$),
 6 participants reported having supplements at home but not taking them regularly. The exception was calcium/vitamin D supplements, which were
 7 commonly prescribed by their GP for their “bone health”. Of the participants who reported taking vitamin D/calcium supplements ($n=9$), all of
 8 them adhered to the RNIs of vitamin D/ and calcium. A common concern regarding taking multivitamin/mineral supplements among some
 9 participants was the risks associated with taking too many medications (i.e., polypharmacy). In some instances, women reported they would not
 10 take any supplements unless they were specifically instructed to do so by their GP:

11 “I needed to do something [about weakness] because I am not taking any supplements... I hate taking tablets so I went along and they
 12 [GPs] said, ‘Look you really need to take some iron tablets’ so I started taking it eventually” (Indian, 75y).

13

14 ***Socio-cultural factors***

15 This theme included key factors related to the changes in participants’ home environments and household role as well as dietary restrictions
 16 women adopt related to their religious beliefs.

17

18 *Changes in home environments and household role*

19 Changes in their home environments (i.e., not living in multi-generational households) resulted in the reduction of daily responsibilities of many
 20 participants. Not having company or the duty of cooking for other family members as they were used to, led them to lose interest and enjoyment

in cooking and eating. In some cases, participants prefer to eat out or skip their meal rather than cooking food for only one person or eating alone:

“I used to do a lot of cooking. When my children were young, I used to bake my own bread as well...Now, [I cook] very little and very simple...nothing sophisticated. You know, if I am out I might eat out” (Indian, 63y).

Variety in their diets appeared to be compromised by the reduction in the number of meals and the time spent cooking. For instance, women reported cooking one day and using leftovers for the following days, especially those living alone:

“She cooks every other day and what is leftover she puts it in the fridge to have tomorrow because she doesn’t want to cook every day, it’s a little bit tiring...[to cook for] herself” (Somalia, 75y).

Dietary restrictions

Some participants reported dietary restrictions linked to religious beliefs (e.g., vegetarianism and fasting practices). Although periods of fasting were related to important events in the religious calendar, some participants continued to fast regularly. Fasting practices throughout the year were reported by Hindu and Muslim women. For example, a Hindu participant explained how she followed a fasting pattern, which included the reduction of the number of meals and/or the prohibition of certain food items throughout the year:

“I fast every Monday; I have only dinner in the evening, that’s all. Sometimes I fast on Wednesday or Thursdays, but this [fasting] Monday is regularly. I have only one meal... Last month I was fasting, I was eating without salt, no salt in my food for a month” (Indian, 65y).

1 Among this sample, some Muslim women tended to fast once or twice per week in addition to the period of Ramadan when they fast for a longer
2 period of time. Fasting practices were considered as rewarding and beneficial for their health:

3 “Ramadan, that's a month [in duration] but she fasts every Monday and Thursday of the week, that gives her more energy and she goes
4 and does a lot of walking. She does fasting and [it] makes her lighter and she goes for a walk” (Yemeni, 90y, frail).

5
6 As shown in the above excerpt, dietary restrictions related to religious beliefs were not perceived as harmful but on the contrary, promoted
7 weight loss and increased their energy levels.

8 *Discussion*

9 The results from this study provide unique insights into dietary intake and key factors influencing the eating behaviors of a sample of first
10 generation migrant women living in the UK. Dietary analysis indicated inadequate intake of energy and various nutrients, with higher
11 inadequacies than those previously reported among white older adults (Vikstedt et al. 2011; Dumartheray et al. 2006), middle-aged South
12 Asians, and African-Caribbean adults in the UK (Sharma et al. 1999; Garduno-Diaz and Khokhar 2014). These differences are likely due to the
13 fact that our sample was more diverse, older, highly inactive, and included only women. Different methodologies used to assess dietary data in
14 immigrant and ethnic minority groups also prevent any direct comparisons (Almiron-Roig et al. 2017).

15 Participant's energy consumption and specific nutrient intakes were significantly lower than the UK RNIs. Low nutrient densities of
16 retinol, vitamin D, magnesium, potassium, copper, selenium, and monounsaturated fatty acids were significantly lower than the
17 recommendations. The few studies and national surveys assessing micronutrient intakes have also found low nutrient intakes of retinol, vitamin
18 D and selenium, particularly in women from South Asian origin (Nelson et al. 2007; Darling et al. 2010; Mavroeidi et al. 2010). Low levels of
19 mono-unsaturated fats have also been reported among South Asians living in the UK (Garduno-Diaz and Khokhar 2014). Among older adults,

insufficient intake of these nutrients has been associated with biochemical and physiological changes that could increase the risks for cardiovascular disease (Rayman 2008), impaired immune function (Marian and Sacks 2009), low bone density (Lanham-New et al. 2011), frailty (Castaneda-Gameros, Redwood, and Thompson 2017), cognitive decline, and oxidative injury that may lead to a decline in physiological function (Cesari et al. 2004).

Dietary restrictions imposed by attempts to lose weight and meet disease-specific recommendations appeared to compromise energy and nutrient intake by influencing the amount, type and cooking methods of foods eaten. It is important to emphasize that some of the dietary changes participants made due to increased awareness of obesity and non-communicable diseases as well as digestion problems can also be considered as facilitators for the adoption of healthier diets. For instance, many women reported having made changes that could potentially benefit their health, such as changing butter for a vegetable spread, or cooking with vegetable oil instead of animal fat. As confirmed by the in-depth probing dietary interview, reductions in salt and fat consumption resulted in meeting the UK RNI values for sodium, total fat, and percentages of saturated and *trans* fat. This finding is in contrast to the higher intakes of salt and saturated fat reported among white British older adults in the UK (Bates, Lennox, and Prentice 2011).

With advancing age there is a sharp decrease in PA, which has been suggested to be one of the main reasons for reduced energy needs among older adults (Westerterp and Meijer 2001). In line with this, study participants perceived their low dietary intake to be a consequence of their low energy expenditure. This perception appeared to be more marked in women who have migrated more recently. It is worth noting, that apart from the well-known barriers that older women face to engage in PA including lack of motivation, skills and knowledge among others, migrant women face additional barriers such as communication problems and modesty concerns (Babakus and Thompson 2012). Given these additional barriers to engage in PA and the high prevalence of nutrition-related non-communicable diseases, lifestyle interventions in this population should consider both dietary and PA behaviors to help maintain a healthy energy balance and optimize nutrient intake.

1 Furthermore, findings from the interviews indicated that some participants who would benefit from nutrient supplementation did not
2 consume them regularly. This appeared to be particularly important for some women whose fears of taking too many medications influenced
3 their supplement use. However, women reported a more regular consumption of supplements if these had been prescribed by a GP such as
4 vitamin D/calcium supplements. This highlights the importance of receiving dietary advice regarding potential nutrient deficits from a qualified
5 and respected health professional. Hence, it is important for health professionals to recognize that the advice they provide needs to address
6 concerns individuals might have about taking supplements along with other medications, and the importance of taking supplements only when
7 needed. It is worth mentioning that individuals with multiple non-communicable conditions may have even higher energy needs than current
8 recommendations (Akamine, Filho, and Peres 2007). Although there is a lack of research exploring dietary intake and supplement use among
9 migrant groups, inadequate levels of vitamin D –produced photochemically in the skin– have been found in South Asian and Black older women
10 living in the UK in comparison to their white counterparts (Mavroeidi et al. 2010; Farrar 2011). Both physiological and lifestyle behaviors (e.g.,
11 darker skin and wearing concealing clothing) have been associated to the inadequate vitamin D levels found in South Asian and Black
12 populations in the UK (Leung and Stanner 2011). Nevertheless, awareness of vitamin D supplementation among non-white population remains
13 low (Lanham-New et al. 2011).

14 Among community-dwelling older people, the association between dietary intake and social support is extremely important. In our
15 sample, the majority of participants come from cultures where multi-generational households are common and where the grandparents are taken
16 care of as they age (Harper and Levin 2005). However, as described by study participants, this familial system is changing and many extended
17 families are being divided into nuclear households, which can result in the older parents or widowed/separated women living alone. Thus, for
18 some participants, meal preparation and consumption have been relegated to a “survival” activity rather than being viewed as a social, family-
19 oriented activity. This finding differs from what has been previously reported in younger migrant women where cooking for their family remains
20 a major responsibility (Nicolaou et al. 2009). In addition, the reduction and simplification of meals prepared at home may potentially impact the

1 variety of foods included in participants' diets if they are eating very similar meals during the week. Therefore, future strategies targeting
2 migrant older women should consider the social component of cooking and eating, especially for those women who have lost their partners or
3 are living alone.

4 Irrespective of ethnic, socio-economic or migration background, participants indicated a good level of knowledge and awareness
5 regarding what constitutes a healthy diet. However, eating is a process that is influenced by many factors and thus, knowledge may not
6 necessarily translate into eating behaviors that promote optimal health and wellbeing (Johnson-Askew, Fisher, and Yaroch 2009). Given the
7 importance of food beliefs and dietary conventions and customs among migrant populations, interventions focusing on eating behaviors need to
8 consider not only nutrition education, but also the importance of family environments, food beliefs and traditions and how these can be honored
9 while promoting healthy dietary patterns. An increased understanding of the factors underlying eating behaviors by diverse migrant groups can
10 assist health professionals and scholars to gain a better understanding of what is needed to help this population improve their nutritional health.
11 This study has several limitations. By design, the sample is small and is not representative; therefore generalizations about these findings must
12 be made with caution. Secondly, using a single 24-hr dietary recall was a limitation. This limitation is common in research conducted with so-
13 called 'hard-to reach population groups with low literacy levels, and where participant burden needs to be minimized (e.g., women who need to
14 be accompanied by a family member) (Garcia and Da 2011). It could be argued that the energy and nutrient inadequacy found in this study was
15 due to under-reporting, which has been suggested to be as high as 30% of energy intake and is more common in older adults, women and
16 overweight individuals (Posluna et al. 2009). However, efforts were made to increase reliability and accuracy of the dietary data by enhancing
17 the 24-hr dietary recalls with an in-depth probing dietary interview, a method that has previously used in population from ethnic minorities to
18 increase the quality of the dietary assessment (Kruger et al 2012). Although using a single recall is a limitation, this allowed collecting data from

participants who are commonly underrepresented in research. Future studies should consider developing or adapting an assessment tool/process to gather dietary intake data among older adults from ethnic minority communities. Furthermore, researchers need to recognize the growing diversity of the UK older population and include a more diverse sample of older adults from migrant origin (e.g., Chinese, African, and Arab groups) in future studies, including national surveys.

It is worth mentioning that the majority of participants were recruited from community centers where health information is provided. This could have influenced their responses regarding their eating behaviors. Additionally, female interpreters were required for some participants, which were selected due to their close connection with the participating communities. Given the limited resources available for this study (e.g., time and funding), we were unable to account for the effects of the interpreters on the qualitative aspects of the research, which may have limited the language trustworthiness of the translated data.

The present study benefits from the inclusion of a population that is commonly under-represented in research, and is at high risk of obesity and related non-communicable diseases (Redwood and Gill 2013). The mixed-methods approach allowed for the examination of dietary intake in community-dwelling, first generation migrant women, and provided a platform to explore the shared and culturally specific factors across women with diverse ethnic, socio-economic and migration backgrounds.

Conclusions

Nutrition-related non-communicable diseases disproportionally affect migrant populations living in Western countries; however our findings suggest that older migrant women living in the UK also have inadequate intakes of several nutrients despite having high rates of overweight and obesity. Although women were knowledgeable about what constitutes a healthy diet, factors such as presence and awareness of obesity and non-communicable diseases, changes to home environments and household roles, as well as dietary restrictions related to religious beliefs were

1 identified as key influences on participants' dietary intake. The personal and socio-cultural factors influencing dietary intake identified in this
2 study may provide useful insights for the development and evaluation of future interventions designed to promote appropriate dietary adequacy
3 among an increasingly diverse segment of the UK population.
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TABLE 1. Summary of participant characteristics (n=76)

Variable	Mean \pm SD or n (%)
Age (y)	70.5 \pm 7.6
Residency in the UK (y)	38.7 \pm 17.1
No. of diagnosed diseases	2.3 \pm 1.5
BMI (kg/m ²)	29.3 \pm 4.9
Normal	9 (11.8)
Overweight	23 (30.3)
Obese	44 (57.9)
Self-reported ethnicity	
African-Caribbean	21 (27.6)
Indian	20 (26.3)
African	10 (13.2)

Arab	8 (10.5)
Pakistani	7 (9.2)
Bangladeshi	5 (6.6)
Irish	5 (6.6)
IMD quintile	
1 (most deprived)	49 (64.5)
2	11 (14.5)
3	7 (9.2)
4-5 (less deprived)	9 (11.8)
Education	
No qualifications	26 (34.2)
Primary school	8 (10.5)
Secondary school	18 (23.7)
Tertiary	24 (31.6)

Marital status	
Married	34 (44.7)
Widowed	30 (39.5)
Single/separated/divorced	12 (15.8)
Living alone	26 (34.2)
Self-reported health	
Excellent	7 (9.2)
Good	36 (47.4)
Fair	20 (26.3)
Poor	13 (17.1)
Supplement use	30 (39.5)
PA level	
IPAQ-E (MET min/wk)	636.0 ± 923.1
% Inactive	53 (70)

BMI= Body Mass Index, IMD= Index of Multiple Deprivation, PA= physical activity,

IPAQ-E= International Physical Activity Questionnaire modified for the

elderly, MET= Metabolic Equivalent of Task

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1 **TABLE 2.** Median nutrient intakes (including supplementation) compared to the UK RNI (*n*= 76)

Nutrient	RNI*	Median	IQR	Median difference from RNI	95% CI of the difference	<i>p</i>
Energy (kJ/d) [†]	6999.8-7301.1	5125.4	3514.6-6515.7	-2171.5	-3338.8 to 1790.8	<0.001
Protein (g/d)	46.5	46.8	34.7-67.9	0.3	-6.8 to 5.80	0.34
Total fat (% TE)	33	29.8	21.2-37.8	-3.3	-6.2 to 0.3	0.02
Energy from SFA (% TE)	10	8.3	5.6-13.8	-1.7	-2.5 to 1.3	0.53
Energy from MUFA (% TE)	12	8.5	5.6-11.8	-3.5	-4.8 to -1.9	<0.001
Energy from TFA (% TE)	<2	0.4	0.2-0.9	-1.59	-1.7 to -1.4	0.02
Retinol (µg/d)	600	191.8	109.3-301	-438.5	-462 to -406	<0.001
Vitamin D (µg/d)	10	2.6	0.7-11.4	-7.4	-8.6 to -0.04	0.02
Vitamin E (mg/d)	5	4.3	2.9-7.3	-0.70	-1.9 to 0.76	0.90
Vitamin C (mg/d)	40	89.5	39.2-158	49.5	15.0 to 66.0	<0.001
Thiamin (mg/d)	0.8	0.9	0.7-1.4	0.13	-6.2 to 0.3	<0.001
Riboflavin (mg/d)	1.1	0.9	0.7-1.5	-0.2	-0.3 to 0.04	0.59
Niacin (mg/d)	12	9.2	5.4-17.9	-2.7	-4.7 to -0.2	0.34
Folate (µg/d)	200	195.5	137.5-331.5	-4.5	-29.0 to 41.0	0.29
Vitamin B6 (mg/d)	1.2	1.3	0.8-2.4	0.1	-0.2 to 0.6	0.01
Vitamin B12 (µg/d)	1.5	2.3	0.8-5.5	0.8	-0.3 to 1.6	<0.001

Calcium (mg/d)	700	566.5	381.3-938.0	-133.5	-229.0 to 56.0	0.25
Magnesium (mg/d)	270	221	157.5-272.8	-49.0	-82.0 to 27.0	<0.01

To be continued

Nutrient	RNI*	Median	IQR	Median difference from RNI	95% CI of the difference	<i>p</i>
Phosphorus (mg/d)	550	863.5	608.8-1124.3	313.5	242.0 to 416.0	<0.001
Potassium (mg/d)	3500	1766.0	1343.0-2573.0	-1734.0	-1887.0 to -1347.0	<0.001
Manganese (mg/d)	1.4	2.7	1.8-4.0	1.3	0.8 to 1.5	<0.001
Iron (mg/d)	8.7	9.1	6.5-14.3	0.4	-1.20 to 1.89	0.13
Copper (mg/d)	1.2	1.0	0.7-1.3	-0.22	-0.4 to -0.13	<0.01
Zinc (mg/d)	7	5.7	4.1-9.2	-1.3	-2.3 to -0.6	0.53
Selenium (µg/d)	60	22.4	10.4-52.6	-37.7	-43.4 to -23.5	<0.001
Sodium (g/d) [§]	2.4	1.4	0.8-2.1	-1.0	-1.3 to 0.3	<0.001

*Department of Health (1991) and Scientific Advisory Committee on Nutrition (2012), [†] Estimated Average Requirement for females 50+ y, [§]The RNI for sodium is the amount that is sufficient for 97% of the population, IQR= Interquartile range, CI= Confidence interval, %TE=percentage of total energy, SFA= saturated fatty acids; MUFA= monounsaturated fatty acids, TFA= trans-unsaturated fatty acids.

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TABLE 3. Summary of key themes from interviews (n=46)

Themes	Sub-themes
Personal factors	Knowledge and perceptions of their diet
	Increased awareness of obesity and non-communicable diseases
	Digestion problems
	Changes in PA
	Healthcare provider advice
Socio-cultural factors	Changes in home environments and household roles
	Meal companionship
	Lack of interest in cooking
	Dietary restrictions

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